Chapter 1

Price Behavior in Commodities Market: Introduction

1.1 Introduction

Commodities have been recognized as a new asset class and they follow distinctive fundamentals unlike other classes of assets like equity or bond. The word commodity means an article of trade. The utterance originated from old French word “commodite” or Latin word “commodus” which means convenience, something that people value or find useful, an item that is bought and sold, especially an unprocessed material. This unprocessed material or natural material can be agricultural produce or mined produce that can be used as input material for further production.

Natural commodities are natural resources like land, water, woods, and mines that may be used for as basic input for further steps of production and they are not directly of use for final consumption. Most of these basic commodities are subject to international trade and are traded on organized spot and futures market.

We can generally categorize commodities into four categories namely energy commodities, exotic\(^1\), metals, agricultural commodities. There is yet another way of categorizing commodities into hard and soft. Soft means tropical commodities \(^2\) or agricultural commodities; harder commodities include harder items like metal. Since primary commodities are used as raw materials in industrial production the demand for commodities is expected to increase with increase in Industrial production. Commodity prices are discovered globally and are influenced by the demand and supply and inventory conditions both in the local and international market.

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1 Exotic means commodities like carbon credits, weather and shipping this classification applicable only to commodity derivative market.
2 According to Jim Roger great investment guru on Commodities
Commodities have been realized as a new asset class. The price behavior in the commodities market has become an important barometer for economic activity. Price behavior of commodities is fundamentally influenced by the supply and demand dynamics, many other factors like whether (season) show their influence on the commodity prices.

In this regard commodity prices are divergent to other asset classes like equity or bonds. The equity valuation/price is based on their net present value of the future cash flow. Commodities prices get influenced by the demand & supply and macroeconomic fundamentals. Unlike equity commodity prices gets discovered internationally.

There is an increasing awareness in investment in commodities markets\(^3\) by means of various innovative products like exchange traded funds on commodities. These developments have brought investment in commodity markets accessible to retail investors. As commonly observed commodity markets are negatively correlated with equity and bond markets, diversification benefits by including commodities in the portfolios gives a natural hedge against inflation. It has been observed that including commodities into a financial portfolio will shift Markowitz frontier upward from the traditional frontier. It indicates higher level of returns from the portfolio.

1.2 Relationship between Spot and Future Prices

Modern day commodity market can be classified as spot and future markets. Spot markets are physical markets where delivery of commodity takes place instantaneously or within a day. Almost all commodities are exchanged in a spot market. In the early days, buyers and sellers used to gather in the market where dealings in commodities led to immediate delivery.

Futures contract is an agreement to buy or sell a set of commodities at a designated future date in a designated future month at a price agreed upon by the buyer and seller at the moment. Commodity futures are a futures contract where

\(^3\) Bulletin Reserve Bank of Australia (2011)
the underlying asset is commodity e.g., wheat, spices, gold. Commodity future can be settled by cash or physical delivery on the termination of the contract. Risk transfer and price discovery are two of the major roles of futures market. By risk transfer we mean transfer of risk from hedgers to speculators and arbitragers make to have an effective price risk management. By price discovery we refer to the usage of futures price information to predict the expected spot market price.

There are many theoretical frameworks available in the literature which describes the dynamic relationship between spot and future prices. Kaldor’s (1939) theory of storage, Samuelson’s (1965) preposition, the net hedging hypothesis etc explains the relationship between spot and future prices. Recent developments in these directions can be observed in Garbade & Silber (1983), Foster (1996) and Figuerolla – Ferretti & Gonzalo (2008) in which the authors tried to capture the impact of other activities like arbitrage on price behavior.

1.2.1 The Relationship between Spot and Future Prices based on the ‘Basis’

The relationship between spot price and futures price can be better understood by studying the basis behavior. Basis is the difference between the cash price and the futures price (or) it defines the relationship between the cash/spot and the futures contract. Positive basis is called backwardation and negative basis is called contango. Spot prices are more volatile when the market is in backwardation.

\[ \text{Basis} = \text{Spot Price} - \text{Future Price} \]  \hspace{1cm} (1)

If we rearrange the equation (1) and solve for Spot price

\[ \text{Spot price} = \text{Basis} + \text{Future Price} \]  \hspace{1cm} (2)

1.2.2 The Relationship between Spot and Future Prices based on the ‘cost of carry model’

One of the most simple and popular model for explaining relationship of futures price and spot price is the cost of carry model. The cost of carry model states that under a perfect market situation the returns in the spot and the futures market

\[ \text{Cost of Carry} = \frac{\text{Cash Price} - \text{Future Price}}{\text{Future Price}} \]

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\[ ^4 \text{A signal of tight supply and demand condition} \]
should be perfectly correlated. This is a fundamental pricing model for storable commodities.

\[ F_t = S_t e^{(r-y)\left\{\frac{(T-t)}{365}\right\}} \] (3)

Where \( t \) denotes the current date, \( T \) the maturity of the contract, \( F_t \) is the commodity futures price at time \( t \), \( S_t \) is the value of underlying commodity. \( r \) and \( y \) are financing cost (risk free rate of return) and convenience yield respectively. This continues compounding interest rate is expected to be constant over the time period \((t, T)\). The study of the basis movement from beginning of the contract to expiration is called convergence. Kaldor (1939) and Working (1949) came out with this cost of carry model.

1.2.3 The Relationship between Spot and Future Prices based on the ‘Theory of Storage’

Theory of storage is fundamental for commodity price modeling. The convenience yield, as introduced in Kaldor’s (1939) theory of storage is meant to represent the benefit of holding the physical commodity instead of a paper contract on that commodity, hence avoiding the cost of disruption in the production.

Convenience yield is the implied yield or non-pecuniary return from holding a commodity. It is a measure of the degree of backwardation in market. Convenience yield is defined as the difference between the positive gains attached to the physical commodity less the cost of storage. Keeping inventory generates lot of advantages –the marginal convenience yield varies inversely with the level of inventories.

The relationship between spot and future prices can be written as

\[ f_t = s_t - (r-y) \] (4)
Where \( f_t = \ln(F_t / F_{t-1}) \) and \( s_t = \ln (S_t / S_{t-1}) \). \((r-y)\) defines the *shape* of the forward curve\(^5\); if positive it is contango situation; if negative it is a situation of backwardation.

### 1.2.4 The Relationship between Spot and Future Prices, the ‘Samuelson Effect’

*Net hedging hypothesis\(^6\)* tells that the spot price and the future price will converge at the end of the future contract or at expiration (Future price = Spot price). The arbitrages make sure that convergence happen at the expiration. Arbitrage is the simultaneous purchase (sale) of commodity and sale (purchase) of the corresponding futures contract, in order to profit from price distortions.

The futures price and spot price converges at expiration (on the expiry of the contract). Samuelson (1965) proposition states that the futures price varies less in comparison to spot prices and the variation of futures price reduces as maturity approaches. This effect is called the *Samuelson effect*.

### 1.2.5 The Relationship between Spot and Future Prices, Recent Developments

Garbade & Silber (1983) establish an equilibrium price relationship between the futures and cash market prices as

\[
F_k = C_k + r \cdot r_k
\]

Where, \( F_k \) is the future price and \( C_k \) spot price of a commodity. \( r \) is the continuously compounded yield per unit time, assumed not to vary with maturity.

The authors observe that the cash and futures markets will be in partial equilibrium if the futures price will equal the cash price plus a premium which reflects the deferred payment on a futures contract.

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\(^5\) The set of available futures prices as a function of their maturity or time.

\(^6\) The Keynesian theory of normal backwardation was one of the earliest theories of inter-temporal futures prices and it postulated that futures prices are biased estimates of forthcoming cash prices because hedgers must compensate speculators for assuming the price risk of holding futures contracts.
Foster (1996) assumes spot and futures prices will have a common evolution, suggest cointegration between spot and futures prices and the cointegrating process being driven by arbitrage. Under the scenario of more elastic the supply of arbitrage, the greater will be the expected level of integration of spot and futures markets.

Figuerolla-Ferretti and Gonzalo (2008) extended the earlier models by incorporating convenience yield explicitly to the cointegrating relationship between spot and future prices. Specifically, in the presence of non-zero storage costs ($S_t$) and convenience yield ($y_t$), the arbitrage condition becomes (in levels of spot and futures prices)

$$F_t = C_t e^{(r_t + s_t)(T-t)}$$

Assuming $T-t=1$ taking log (lower case shows variables are log)

$$f_t = c_t + r_t + s_t$$

Assuming interest rate and storage cost to be evolving according to the equations

$$r_t = + I(0) \text{ and } S_t = + I(0)$$

$$f_t = c_t + I(0) \text{ where } = +$$

It indicates $f_t$ and $c_t$ are cointegrated.

The equilibrium relation between spot and future is given as

$$C_t = \beta_2 f_t + \beta_3 + I(0)$$

1.2.6 Other Factors Affecting Price behavior Mean Reversion and Seasonality

The mean reversion is a phenomenon which gets much attention in the recent literature on commodity price behavior. Mean reversion is defined as the tendency for a stochastic process to remain near, or tend to return over time to a long-run average value. Mean-reversion models have more economic logic compared to other stochastic models like Geometric Brownian Motion (GBM) which is used for modeling commodity prices. In the financial-economics literature we find different ways to model the mean-reversion process.

Seasonality is another factor impacting the price formation of commodities prices. By seasonality we mean periodic, recurring and predictable pattern in demand and supply of commodities as per the seasons. By seasonal we mean any
expected fluctuations with a period of less than one year. So they are different from cyclical fluctuations which may have long period cycles. Seasonal variations have significant economic implication with respect to supply management and storage costs.

1.3 Motivation Behind the study

Commodity price risk management is an important element in the Enterprise Risk Management both for developed and developing counties. Over the decades, commodities have captures the attention of famous economists such as Keynes, Kaldor or Working. BRICS nations (Brazil, Russia, India, China and South Africa) the five major emerging nations are growing big because of its commodities resources. Ability to predict the commodity prices with certainty will benefit the framers or the industrializing emerging nations. Carter (1999) finds disjointed works in commodity futures market with very less research addressing the fundamental issues in commodity markets with good economic content. There are few papers available on Indian commodity markets but the issues like mean reversion, seasonality, forecasting performance etc are not addressed in detail. The existing research gap motivates this study which will address the relationship between spot and future prices, presence of mean reversion and seasonality in the Indian commodity markets. Further the study will be focusing on the commodity price forecasting.

1.4 Objective of the research

1. To examine for relationship between futures and spot commodity prices in India.
2. To test for mean reversion in Indian commodity market
3. To test for seasonality in commodity futures market.
4. To model and forecast commodity prices in Indian commodity market.

7 “Commodity futures market: a survey”
1.5 Organization of the thesis and summary of chapters

This thesis is systematically arranged into eight chapters. The first chapter gives a brief introduction the study which highlights the importance of commodity markets and price behavior. Moreover it provides a brief description of the theoretical frameworks which looks in to the price behavior in the commodity market. Motivation behind and major objectives of the study also stated in the chapter. The second chapter provides the review of relevant literature for the thesis. It examines the theoretical and empirical papers on commodity price forecasting, mean reversion and seasonality. The third chapter looks at Indian Commodities Market starting from the history of evolutions of commodity futures market in India, commodity spot market the market microstructure, regulators, participants, exchanges, treading mechanism and various issues pertinent to Indian market commodity market. The fourth chapter explains the relationship between spot and futures market which is the first objective of this thesis. The fifth chapter describes mean reversions in Indian Commodities market. The sixth chapter examines the presence of seasonality in the Indian commodity prices. The seventh chapter looks at commodity price foresting and the last chapter in this thesis provides the summary of the study, recommendations and conclusion.

1.6 Summary

Commodity markets provide very important investment opportunities and have certain advantages over other financial markets while considering risk management. There exists greater transparency of the fundamental behaviour commodities prices the demand and supply factors. Growth of commodity markets with new instruments makes it more accessible to a larger number of people. Introduction of future trading brings out many issues regarding the price volatility. As commodity markets provide a new category of asset classes, price behavior in the commodity market have been considered as an important economic indicator. Understanding the importance of recent development in the Indian commodity markets and research gaps the present study aims to address in detail some aspects of the commodity market in India. The relationship between
spot and future prices, presence of mean reversion and seasonality are the major issues considered under the study. The real world price behaviour in commodities market is far richer than the existing body of knowledge in commodities price forecasting.